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*Petroleum Lubricating Greases**

MARTIN B. CHITTICK

The American Society for Testing Materials has tentatively defined a petroleum grease under A. S. T. M. Designation D 288-36 T as follows:

"A semi-solid or solid combination of a petroleum product and a soap or combination of soaps, with or without fillers, suitable for certain types of lubrication."

The scope of this paper is primarily limited to those products falling within the limits of this definition, the trend in research in the field of lubricating greases, the various physical and chemical tests that have been developed for application to control the quality of greases as well as predicting their service performance. Due to the fact that the term lubricating grease is a generic term, a sharp line of demarcation between certain classes of lubricants is impossible. It is for this reason that the above definition, while definitely a progressive step, leaves much to be desired. Take, for a typical example, the so-called extreme pressure lubricants, which fall in two general classes. In the first class can be placed the lead soap-active sulfur type of extreme pressure lubricant, which falls within the definition of a petroleum lubricating grease. As against this type of lubricant, we have the extreme pressure lubricant consisting of mineral oil with an organic additive agent, which, in general is commercially considered as a grease, yet does not fall within the scope of the definition.

The tractor roller bearing greases, consisting of a mineral oil containing varying proportions of abrasive free asbestos floats are generally classified as lubricating greases, yet do not meet the current definition.

This confusion as applied to lubricating greases is generally recognized and is being given considerable study by The National Lubricating Grease Institute. This situation suggests the advisability of a complete revamping of nomenclature as applies to lubricants. It is suggested that consideration be given to the use of the single term "LUBRICANT," under which all products, mineral oils, marine oils, waxes, vegetable oils, greases, special compounds, etc., used as lubricants would be classified with subclassification under which the various lubricants could more accurately be defined.

In any discussion of lubricating greases their primary function, namely to reduce friction and excessive wear, must be considered in relation to lubricating oils. In general, greases are employed where the operating conditions are such as to make lubrication by oil impossible or undesirable. Mechanical systems without oil tight housing, open gears, and high operating temperatures offer typical examples in such cases.

The wide variety of commercial products that have found their way on the market under the name of lubricating greases has led to considerable delay in developing acceptable procedures for testing greases. In general those tests that have enjoyed commercial acceptance have been developed under the sponsorship of The American Society for Testing Materials. These tests are as follows:

Greases, Analysis of, A. S. T. M. D 128-37.

Penetration of Greases and Petroleum, A. S. T. M. D 217-33 T.

Neutralization Number of Petroleum Products and Lubricants, A. S. T. M. D 188-27 T.

Water in petroleum products and other bituminous materials, A. S. T. M. D 95-30.

Corrosion (Metal Strip) Federal Specification VV-L-791A.

In addition to these tests, there are A. S. T. M. tests applying to the component parts of grease, more particularly the mineral oil. These have been discussed in a comprehensive manner by Geniesse (1).

The significance of these tests is comprehensively discussed in "The Significance of Tests of Petroleum Products"—1934, published by the American Society for Testing Materials.

Supplementing the tests developed by the A. S. T. M. various laboratories have developed individual tests which can be classified according to the various physical and chemical properties of grease.

Research work on lubricating greases has been given a tremendous impetus within the past three or four years with the result that better quality greases and consequently better service performance is being secured today than at any time in the past. The progress that has been made in the development of anti-friction bearings has been one of the major contributing factors to the research work on grease. This is particularly true as regards the chemical stability of grease and mechanical testing procedure.

In presenting a resume of the development work resulting in accepted procedures of tests on greases, as well as the published research work, it is patently impossible to maintain a proper proportion as much of the earlier work, which in the light of present day knowledge, appears relatively insignificant, nevertheless must be credited with initiating research work ultimately resulting in our current research activities in lubricants.

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* Courtesy American Society for Testing Materials.

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Two possibilities suggest themselves for the presentation of this material. The first and most simple is to classify the work under the rational general headings of physical and chemical. The other method takes up the various characteristics as structure, consistency, chemical and physical stability, etc. The major difficulty of applying either of these means, or any logical method, lies in the fact that so many investigators have presented their research work involving various phenomena, consequently resulting in considerable over-lapping. Therefore, an arbitrary method is adopted with the hope that subsequent work will automatically rationalize the subject. A discussion of consistency is indicated for first consideration due to the wide commercial use of this property.

Consistency

The term consistency, as applied to a lubricating grease, refers to the flow-pressure characteristics of a grease, but in practice the term has unfortunately been adopted too loosely and with no relation to other characteristics such as structure and texture. Commmercially, the A. S. T. M. Penetration of greases (2) is the most widely used test as a measure of consistency. This procedure has, however, limited application since it cannot be used with any degree of accuracy on semi-liquid greases and cannot be employed where small samples of harder greases are involved. This test is invaluable for maintaining uniformity of consistency on actual production and has contributed to a major degree in a greater uniformity in commercial greases.

Unfortunately, too wide acceptance has been given to the consistency of a grease as an indication of performance in service, particularly as to leakage. This is an erroneous conception and one to be discouraged. This is demonstrated by the fact that two greases with identical consistencies, but different structure, may act entirely different in identical service conditions, one functioning satisfactorily, while the other may leak so badly as to be entirely unsatisfactory.

Several investigators have studied the property of grease consistencies with the general objective of arriving at an all purpose procedure covering the entire range of consistencies and for the purpose of predicting service. Some of these investigations indicate some promise and should be studied further. Porter and Gruse (3) adopted a modified Bingham Plastometer to measure consistency. Lederer and Zublin (4) developed a ball-viscosity method for controlling the consistency of soft and stringy greases. Arveson (5) has studied the flow of lubricating greases using the constant shear viscosimeter. This work presented some interesting phenomena in grease behavior. That it has not been wider used to some extent can be attributed to the high cost of the necessary equipment as well as the time and expense of the individual tests.

In connection with Arveson's work it should be noted that it has been a controversial matter as to what part the viscosity of the lubricating oil plays in the actual service of a grease, and to what extent this service is affected by the consistency of the grease as imparted by its soap content, and kind of soap. It is held by some that the soap merely acts as porous reservoir for holding the lubricating oil, while others maintain the soap itself performs a lubricating function.

Some investigations on the affect of temperature on consistency are highly desirable particularly at operating temperature. The temperature at which A. S. T. M. penetrations are determined, 77 F., is satisfactory for control of uniformity, but is of little or no value in predicting performance. It is possible that research work in this direction would make possible the establishment of a consistency index analogous to the viscosity index of lubricating oils.

Nelson's (6) investigations, employing a modified Gardner Mobilometer, on the consistencies of fluid and semi-fluid greases have been adopted in several commercial laboratories for controlling the consistencies of gear greases, mine car greases, and textile greases with good results. Both this procedure and the MacMichael Viscosimeter will bear further investigation, particularly from the standpoint of reproducibility of results and costs of individual tests.

The investigations of Knopf (7) have resulted in the development of several interesting pieces of apparatus and tests for consistency that hold considerable promise if they can be simplified and the cost reduced. An outstanding advantage in the Knopf tests is the small amounts of material required for test.

The Karns-Maag method for determining consistencies has found considerable favor in the past in some laboratories, but due to the fact that it offers no outstanding advantage over the A. S. T. M. procedure and that no factor exists for conversion to the equivalent A. S. T. M. consistencies, it appears to be losing favor.

The lack of any commercially accepted standards for the various consistencies of greases has resulted in considerable confusion and misunderstanding in the past. To correct this situation a National Lubricating Grease Institute Classification of greases, based on the A. S. T. M. worked penetration, has been proposed and published for information. This classification is designed to eliminate confusion for consumer and producer alike as to consistencies applying to the various grades. It should be pointed out that this classification in no manner indicates quality or performance. It in no way indicates what the chemical or physical characteristics of a grease may be aside from the consistency and the standard grade for that consistency. In this respect, it is comparable to the Society of Automotive Engineers Crankcase Oil Classification. This grease classification follows:

National Lubricating Grease Institute Grade	A. S. T. M. Worked Penetration
No. 0	355-385
No. 1	310-340
No. 2	265-295
No. 3	220-250
No. 4	175-205
No. 5	130-160
No. 6	85-115

It should be noted that a gap in consistency exists between each grade, consequently, there is no overlapping of grades and also no possibility of one grade being substituted for another.

The Bearing Engineers Committee of the anti-friction bearing manufacturers have made a real contribution in the development of a penetration test as reported by Ahlberg (8). This procedure has the advantage of utilizing small samples of grease and the report indicates that the results can be converted into equivalent A. S. T. M. penetrations through the use of a factor. It is to be hoped that further work can be reported on this test and further cooperative work carried out. More recently Kaufman, Finn and Harrington (9) have developed a miniature pentrometer for determining the consistency of lubricating greases which gives fair reproducibility and may be roughly corelated with the A. S. T. M. penetrations. Since the latter procedure has the outstanding disadvantage of requiring large size samples, approximately 500 grams, this new miniature equipment has a distinct advantage in requiring samples of 3 to 5 grams.

Structure

The structure, or texture, of a lubricating grease is one of the primary characteristics that contributes to the ultimate service performance. Until recently, not too much has been known of grease structure. While the terms "smooth" grease, "fibre" grease, and "stringy" grease have been used commercially for a long time, the fact remains that technically little was known of the basic reasons for the different structures.

A classification for lubricating greases, based on the length of the soap fibre, has been suggested by Farrington and Davis (10) as a result of their study of the texture and structure of lubricating greases by means of photomicrographs.

In considering structure, a recent classification of petroleum greases into three soap-oil systems as developed by Lawrence

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GEORGE W. MILLER . . . *Editor*
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(11) holds promise of explaining some of the phenomena observed in grease performance. As a result of his studies, Lawrence has offered three soap-oil systems: (a) True solutions whose viscosity may be but little greater than those of the oil alone. (b) True gel, a transparent, homogeneous elastic substance, (c) Pseudo-gel or paste of crystalline soap suspended in oil.

Gruse (12) and associates have presented an excellent paper on the chemical and physical evaluation of lubricating greases in which emphasis is laid on structure, as well as consistency, physical and chemical stability. The theories and factors affecting structure are capably discussed and amply

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A. P. I. Committee Explains Program

A short while back, the American Petroleum Institute formed a Committee on Lubrication which is now headed by R. A. Ludlow as director. The Committee has issued a statement explaining its program. Copies of the complete statement can be obtained from Mr. Ludlow at 50 W. 50th Street, New York.

The Committee proposes an educational program to bring automobile users to the realization that long intervals between crankcase changes and lubrication jobs is a matter for concern. The Committee will co-operate with the automotive and other industries, foster sound policies in merchandising quality lubricants and undertake any and all steps which will tend to bring about reasonable lubrication periods and better agreement as to methods and mileages.

NOTICE

To those who have not returned "correct address" card enclosed with last issue, kindly do so at once so that our mailing list can be brought up to date.

*Car Manufacturers' Latest Recommendations**

1940 DODGE AND PLYMOUTH 7 PASSENGER MODELS

On 1940 Dodge D14 and Plymouth P10 7 passenger models only, there is a universal joint spline, requiring lubrication with Chassis lubricant through fitting every 2,000 miles. There are three universal joints on these 7 passenger models.

1940 PACKARD CLUTCH RELAY LEVER

On *some* early 1940 Packard 110 (6) and 120 (8) models, there is a clutch relay lever which requires lubrication with Chassis Lubricant every 1,000 miles. This point is lubricated through a fitting, reached from under the hood.

This clutch relay lever lubrication point will be found on *all* 1940 Super 8 models.

1940 STUDEBAKER UNIVERSAL JOINTS

The manufacturers' recommended mileage interval for universal joint lubrication on the Commander (10A) and President (6C), 1940 models, has been 5,000 miles and for the Champion (2G), 10,000 miles. It is now recommended that the universal joints on *all* 1940 models be disassembled and lubricated with Chassis Lubricant every 10,000 miles.

1940 PONTIAC OIL FILLER CAP

On all 1940 Pontiac models, whenever oil is added to the engine crankcase, care should be taken to replace the filler cap in the proper position on the filler tube.

The filler cap is designed with an air inlet opening. This opening is provided as an air entrance to the crankcase ventilating system, and the filler cap should always be placed on the filler tube with the opening toward the front of the car.

The manufacturer has provided an easy means of replacing this cap but, in many cases, careless station attendants have forced the cap onto the tube improperly. There is a crimped seam in the metal ring at the bottom of the cap. This seam should register with the groove provided at the upper end of the filler tube. Force is not needed to replace the cap. Simply turn the cap with the fingers until you feel the seam register with the groove, then look to see if the opening is toward the front of the car, and press the cap down onto the tube in the usual manner.

STARTER PEDAL GUIDE ROD ON 1939-40 PONTIAC EIGHT

The starter pedal shaft on 1939 and 1940 Pontiac eight cylinder models passes through a guide attached to the dash. This guide is provided with a graphite-rubber compound bushing.

While lubrication at this point is seldom required, cases have been found where mineral oil has been applied, resulting in swelling of the bushing and binding of the bushing on the starter pedal shaft.

Mineral oil should never be used. If lubrication seems necessary, use only a special rubber lubricant. If the use of mineral oil has already caused seizure at this point, the bushing should be replaced by an authorized Pontiac dealer.

NEW OLDSMOBILE HYDRA-MATIC DRIVE INSTRUCTIONS

Following are the instructions for proper maintenance of the Oldsmobile Hydra-Matic Drive recently issued by the factory:

1. The fluid in Oldsmobile's Hydra-Matic Drive should be changed every 5,000 miles. Check fluid level every 2,500 miles and add, if necessary.

2. IMPORTANT! Use only Oldsmobile Hydra-Matic Drive Fluid. This fluid is available through authorized Oldsmobile Dealers everywhere. Total capacity of unit is 10 qts.

3. In cases of emergency, when Hydra-Matic Drive Fluid is not available, any good grade of 20W Motor Oil will operate satisfactorily *for a temporary period*. When such oil is used, however, it should be replaced as soon as possible by Oldsmobile Hydra-Matic Drive Fluid.

4. If it should ever be necessary to start the engine by pushing the car, place the control level in "N" position until a speed of approximately 20 m.p.h. has been attained. Then move control lever to "Hi."

5. If the car should have to be towed to a service station for repairs, make sure the control lever is in "N" position.

It is to be particularly noted that the use of Oldsmobile Hydra-Matic Drive Fluid *only* is very important to the satisfactory operation of the unit, and that if, in a case of emergency, a 20W Motor Oil is used, it should be replaced as soon as possible with Oldsmobile Hydra-Matic Drive Fluid.

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indicates the necessity of further research work on structure.

It should be pointed out that the structure of a lubricating grease is so interlocked with the physical and chemical characteristics that it presents an extremely complicated problem. Pertinent data are required on the effect of structure on the service performance of greases, and why certain structures are more desirable under some applications than others. For example, it is well known that the structure of a grease may be altered considerably by agitation under service conditions, as in the case of a soda soap grease, which can be liquified at 450 F. and cooled to atmospheric temperature without agitation normally resulting in a short fibre grease. This same product may be made tough and long fibred by heating to approximately 200 F. and working.

Dropping Point

There has, erroneously, crept into more or less common use the term "melting point" applied to greases. Consequently, considerable misunderstanding has resulted, and more important, grease lubrication has suffered. Gillett (13) first suggested the "dropping point" method of test. This test measured the temperature at which a small volume of grease adhering to the bulb of a thermometer softened sufficiently to drop off. Committee D-2, American Society for Testing Materials, has developed and published (14) a proposed method of test for determining the dropping point of lubricating greases using a modified Ubbelohde tube. Like most methods of this general type, this is the temperature at which the sample softens sufficiently to drop when heated under controlled conditions.

It is apparent from the complicated nature of a grease that it is impossible to have a true melting point.

The dropping point is important in predicting the ultimate performance of a grease, particularly under high temperature operating conditions. This is especially true in industrial applications.

(To be continued in next issue)